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Research article

The Measurement and Asymmetry Tests of Business Cycle: Evidence from China

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Abstract: In this paper, the dynamic factor model (DFM) is employed to measure China's business cycle with macroeconomic indexes from January 2000 to September 2016, so as to construct a business cycle measurement system in line with China's actual situation, based on which effective and timely macroeconomic regulation policies will be formulated to make China's economic operation stable and controllable. The empirical results show that China's economic operation has significant co-movement and asymmetric features; the dynamic factor model can depict China's business cycle factors and describe the internal co-movement operating mechanism of the economic fluctuation; the "three-tuple" method is used to test the deepness and steepness of asymmetry in each cycle stage, and it is found that the asymmetries of different cycle stages bear different characteristics, and China's current economic operation is in a stage where the long-term trend is downward adjustment and convergence.

Key Words: business cycle; dynamic factors; asymmetry

1. Introduction

The issue of business cycle has always been a concern in economic theories, and an objective and accurate understanding of the business cycle plays an important role in grasping the trend and state of economic operation and implementing positive and effective regulation policies. With the

deepening understanding of the law of economic operation, governments begin to consciously control its fluctuation. But due to the close relationship between economy and finance, the frequent outbreak of financial crisis continues to impact the economic operation, making the business cycle reveal more significant complexity.

After the outburst of the 2008 financial crisis, the world in general took active macroeconomic policies to regulate economic operation, which, to a certain extent, stabilized the fluctuation of the business cycle, and the world economy steps into a slowdown stage. Since 2014, the world economy has shown moderate post-crisis recovery. But the current economic slowdown does not mean the disappearance of the business cycle, and the future development of the global economy is still facing a lot of uncertainty. At present, China's economy is in a transitional period. With the change of the economic stage and the implementation of positive government macroeconomic regulation measures, China's economic fluctuations tend to ease, and China's economy enters into a moderately-growing New-Normal stage. At this stage, the relationship among macroeconomic variables change, and their co-movement will affect the business cycle measurement. Meanwhile, the fluctuation trend of China's business cycle displays new variation, and the mean value of economic growth and the dynamic change of fluctuation impose important trend influence on the economic operation. As the New-Normal economy is one of the presentations during China's economic development, both economic growth and business cycle situation are related to whether asymmetry exists in the business cycle fluctuations during this period. Therefore, the business cycle measurement and corresponding asymmetric tests are important empirical basis for judging the future economic growth trend.

Burns and Mitchell (1946) pioneered the definition of the business cycle, that is, the business cycle is a form of macroeconomic fluctuation, which presents as a number of economic variables enter at a similar pace into the alternating cycle of four stages, i.e., prosperity, recession, depression, and recovery, and any single business cycle will not be a simple repetition of the previous cycle. Each cycle of business exhibits differences in amplitude, range and duration. This proves that business cycle has two characteristics: first, changes in the business cycle have the feature of co-movement; second, the development of the business cycle is asymmetric. One of the most important subjects is the measurement of the business cycle, and different research methods have emerged, among which the most significant ones are the National Bureau of Economic Research (NBER) approach, the BB method (Bry and Boschan，1971), the BBQ method (Harding and Pagan, 2006; Chen and Kong, 2007), and the Markov mechanism model method (Bredin and Fountas, 2006; Chauvet and Piger, 2008). In addition, for the selection of indexes to describe the business cycle, Zarnowitz (1984) pointed out that the analysis used GDP simply only reflects the change of economic growth, which should be called the "growth cycle", while a comprehensive reflection of the changes in the overall macro-economy can be called "business cycle".

Economists have done a lot of research on the co-movement of economic variables. The co-movement of the business cycle, as an important part of the business cycle theory, is described as the synchronization and coherence behavior of the major macroeconomic variables in the course of the business cycle, or the almost synchronous motion characteristics of main macroeconomic variables and the overall economic activity demonstrated in the business cycle (Canova and Dellas, 1993). Corresponding to the description of co-movement, Burns and Mitchell (1946) used a large number of charts to illustrate the synchronization of different economic sectors in the business cycle. Lucas (1977) emphasized the co-movement as the co-fluctuation among different macroeconomic variables. The co-

movement can be described as procyclical, countercyclical and acyclical in the direction, which describes the coordinated characteristics of the business cycle. Stock and Watson (1989, 1991, and 1993) in the NBER used factor analysis to extract a single common factor from a variety of variables to establish a dynamic factor model (DFM) that fits well the historical U.S. real GDP trajectories, describing the co-movement characteristics of the business cycle very well. Conley and Dupor (2003) employed the input-output model to simulate the cross-sectional productivity activities of the U.S. economy and found that sectors with similar input-output relationships tended to change together. Chen (2004), Liang and Teng (2007), Huan and Liang (2016) used the similar method as Stock and Watson's to get the periodic fluctuation components of China's macroeconomic variables through the filter, and analyzed their co-movement features.

The asymmetry of the business cycle is characterized by significant differences in the duration of the process of prosperity and decline, the speed of conversion and the depth of development. Neftci (1984), for the first time, applied econometric tools to analyze the asymmetry, using the finite state Markov process to discover the "steep-rise slow-fall" feature of the US unemployment rate after the War. Hamilton (1989) proposed a Markov switching (MS) model with multiple structural variances, which can depict the change and transformation process of time series variables under different states, and capture the more complex dynamic evolution process of time series variables. Kim and Nelson (1999), Mills and Wang (2002) also used the Markov process to study Friedman's plucking theory. Kiani (2005) tested the asymmetry of real GDP growth rates in Canada, France, Japan, the United Kingdom and the United States through artificial neural networks and found statistically significant asymmetries in these industrialized countries. Knuppel (2009) utilized the skewness coefficient of the Markov auto-regression to determine the depth asymmetry of the time series and found that the U.S. real GDP exhibit significant depth asymmetry. Many Chinese scholars exert asymmetric tests to Chinese business cycle sequence. Such as Liu and Fan (2001), Xu, Zhu and Liu (2005), Zhang and Kang (2007), Liu and Liu (2016), they all use the trend decomposition method of HP filter to test the asymmetry of some macroeconomic variables such as GDP, money supply (M2), government revenue, government spending, investment, import and export. But they drew different conclusions mainly because of variant sample interval selection and different variable definitions. Liu and Wang (2003), Guo, Liu and Liu (2005), Chen and Liu (2007) divided the business cycle into different mechanism states, and used Markov mean and variance mechanism switching model and Bayesian Gibbs sampling non-parameter method to study the asymmetry of economic growth volatility since the reform and opening up in China.

In the earlier literature, the measure of the business cycle is simple from a certain point of view, the method is also the lack of nonparametric methods of use. In this paper, taking into account the business cycle is the performance of economic variables co-movement, from the macro-control policy objectives and the economic system synchronization situation to run the two aspects of the two groups of indicators system comparison, the use of dynamic factor model to measure China's business cycle, and uses BB method to identify its turning point, and then innovatively use nonparametric methods for each business cycle of the asymmetry test. This paper is divided into five parts. The second part is the measurement of business cycle and the description of test methods. The third part is about the selection of two sets of macroeconomic indexes and the use of dynamic factor model for empirical analysis of China's business cycle; then the structure of the business cycle factor is compared with the real GDP growth rate, and a business cycle factor is synthesized and the turning

points are identified. In the fourth part, the nonparametric method is employed to test the asymmetry of the business cycle, and the distribution simulation method is used to describe the asymmetric morphology. The fifth part is the conclusion.

2. The Measurement and Test Methods of Business Cycle

Business cycle has the co-movement characteristic, that is, all kinds of economic activities rise or fall at the same time, which usually manifest as the synchronization among various economic sectors, and reflected in the synchronous changes of investment, consumption, export, employment and other economic variables in macroeconomic statistics. The dynamic factor model, established by Stock and Watson (1991), is a probabilistic model that describes the co-movement of a series of macroeconomic variables. The model is considered to have a common trend component, namely the common factor, which is an unobservable Latent variable among macroeconomic variables.

Assuming Y_{it} is macroeconomic the indicator i, with $i=1,2,\cdots,N$, and $t=1,2,\cdots,T$; The random variable and the dynamic factor follow an autoregressive process. The dynamic factor model is:

$$Y_{it}=\beta_i+\gamma_i C_t+\nu_{it} \tag{1}$$

$$D_i(L)\nu_{it}=\varepsilon_{it},\varepsilon_{it}\sim i.i.d.N\left(0,\sigma_i^2\right) \tag{2}$$

$$\varphi(L)C_t=\eta_t,\eta_t\sim i.i.d.N\left(0,\sigma_\eta^2\right) \tag{3}$$

Where C_t is the synthesized dynamic factor, i.e., the non-observable common factor of each economic variable; β_i is a constant, and ν_{it} is the random variable, and the sum of the two variables is the unique heterogeneity of economic components. $D_i(L)$ and $\varphi(L)$ are lag operator polynomials in the autoregressive process, with ε_{it} and η_t are mutually independent and subject to normal distribution.

In the empirical study, the DF model is over-parameterized, and it is unrecognizable; in addition, macroeconomic variables are mostly integrated variables with random trend. Therefore, it is necessary to standardize the economic variables by taking the change rate of each variable, that is, the first-order difference or the natural logarithmic growth rate.

The method used to test the asymmetry of business cycle is the "three-tuples" test employed by Randles et al. (1980) and Liu and Liu (2009), which can determine the depth and steepness asymmetry of each economic cycle. All possible three-element combinations $\left(x_i,x_j,x_k\right)$ are extracted from the sequence to be tested. Where $0<i<j<k\le T$, and the following function is calculated:

$$f\left(x_i,x_j,x_k\right)=\frac{1}{3}\left[sign\left(x_i+x_j-2x_k\right)+sign\left(x_i+x_k-2x_j\right)+sign\left(x_j+x_k-2x_i\right)\right] \tag{4}$$

Where $sign(\ )$ is a composite function with values of 1, 0, and -1, thus the value set of $f(\bullet)$ is $\{-1/3,0,1/3\}$. If the three elements are right-biased, $f\left(x_i,x_j,x_k\right)=1/3$, and similarly, if the three elements are left-biased, $f\left(x_i,x_j,x_k\right)=-1/3$.

The asymmetry of the sequence can be tested by constructing the following statistics:

$$Z = \frac{\widehat{\eta} - \eta}{\sqrt{\widehat{\sigma}_{\eta}^2 / T}}, \quad \hat{\eta} = \binom{T}{2}^{-1} \sum_{i<j<k} f\left(x_i, x_j, x_k\right) \tag{5}$$

Razzak (2001) provided the estimating method of the expectation and the variance of $\hat{\eta}$. The statistic Z can be used to test "depth asymmetry" and "steepness asymmetry" for the original sequence and the difference sequence respectively, where "depth asymmetry" is characterized by gradual upward slopes during expansions and steep downward slopes during recession and "steepness asymmetry" is characterized by relatively deep troughs and low peaks. In the process of the phased inspection of business cycle, it is often to have the situation where some business cycle stage has a short period and few data. The "three-tuple" test has a comparative advantage in the test of small sample data, just as Razzak considered that as long as the data length is greater than 5, the "three-tuple" method can initially determine the asymmetry in the business cycle.

3. Measurement of China's Business Cycle

Although the dynamic factor model has been widely used, it must depend on the selection of certain variables. The index selection method lacks the statistical theory support, and directly affects the measurement results. Therefore, on the basis of model requirements, the index should be selected according to the following principles: the indexes should not only be consistent with the changes in economic development trend, and reflect changes in economic activity, but also be mutually independent and representative. The synchronization and covariance among economic indexes are the theoretical basis of the business cycle index system.

3.1. Index Selection and Data Processing

Keynes (1936) pointed out the necessity and importance of government intervention in the face of insufficient supply and demand and serious unemployment. The state used all kinds of means to adjust and control the national economy and ensure the coordinated development of social reproduction. The business cycle fluctuation has certain influence on the social resources and the productive forces. The macro-regulation focuses on coordinating the economic operation of the whole society to regulate the supply and demand, maintaining a moderate growth of the national economy, achieving full employment of the labor force, keeping the international balance of payments, and stabilizing the overall price level. It can be seen that macroeconomic regulation can stabilize the fluctuation of the business cycle, slow down the fluctuation range, and prolong the stage of economic expansion and shorten the stage of economic contraction, resulting in the asymmetry of the duration of the stage. From the indexes which reflect the macro-regulation objectives to observe the economic operation cycle, both the coordination of economic operation departments and the

asymmetry of the business cycle can be explained and checked. Thus the selected operating variables are urban employment, total current account loans, industrial value added, and household consumption.

Investment, consumption and exports are three main driving forces for economic growth. China's economic growth mainly depends on investment and exports, thus the variables of investment, consumption and exports are the main targets. The higher and lower growth rate of money supply will lead to the relative fluctuation of the total demand and the actual economic activity to the long-term trend. Finance is at the core of the modern economy, especially in short term, the financial cycle has great influence on the business cycle. After the outburst of the global economic fluctuation caused by the subprime crisis, China's financial impact factors may be significant, thus the introduction of financial and monetary factors into the analysis of business cycle measurement. Therefore，In this paper, the four indexes of investment, consumption, export and currency are used to reflect the changes in the macroeconomic field. The specific operational variables are selected as follows: the investment in fixed assets, the total retail sales of social consumer goods, total exports and broad money supply M2.

For the purpose of obtaining the stationary cycle component of the index growth without the trend, the index is logarithmically differentiated and then seasonally adjusted to eliminate the influence of seasonal and irregular factors. In order to reduce estimated parameters, the mean of the growth rate sequence is removed so as to eliminate the heterogeneity component of the intercept term. In this paper, monthly data from January 2000 to September 2016 are selected to establish the DF model. Table 1 is about the selected indexes of the model and their description.

Table 1. Indexes that reflect the business cycle and their description.

Column One		*Column Two*	
Index Name	*Index Description*	*Index Name*	*Index Description*
Employment Growth Rate (EGR)	reflecting the increase in employment	Growth Rate of Investment in Fixed Assets (IFAGR)	reflecting the level of fixed asset investment activities
Current Account Credit Growth Rate (CACGR)	reflecting the level of credit changes in the balance of payments	Growth Rate of Total Retail Sales of Consumer Goods (TRSCGGR)	reflecting the fluctuation degree of commodity purchasing power
Industrial Added Value Growth Rate (IAVGR)	reflecting the growth rate of economic scale	Total Exports Growth Rate (TEGR)	reflecting the degree of change in the scale of trade
The consumer Price Index (CPI)	reflecting the degree of price fluctuations	M2 Growth Rate (M2GR)	reflecting the degree of change in money supply

3.2. Model Selection and Results Comparison

There is delay structure in the dynamic factor model, which means, there are lagged orders in Formula (2) and (3). According to the principle of BIC, the parameters of the model are set to order 1 and 2. Table 2 lists the estimation results of the DF model parameters.

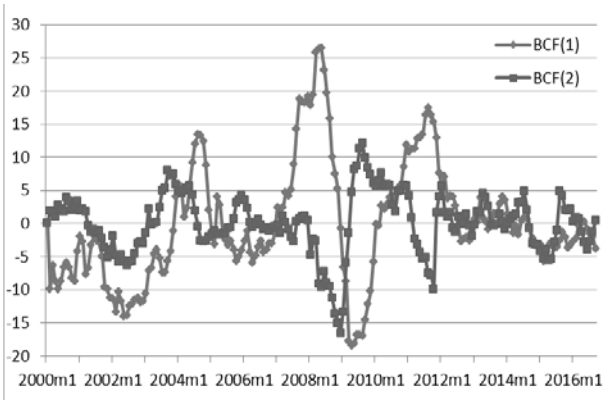
Two non-observed common factors BCF (1) and BCF (2) can be obtained from the final data of each group according to the DF model and its estimation, BCF time series data are synthesized from these two common factors and compared with Quarterly GDP growth. See Figure 1.

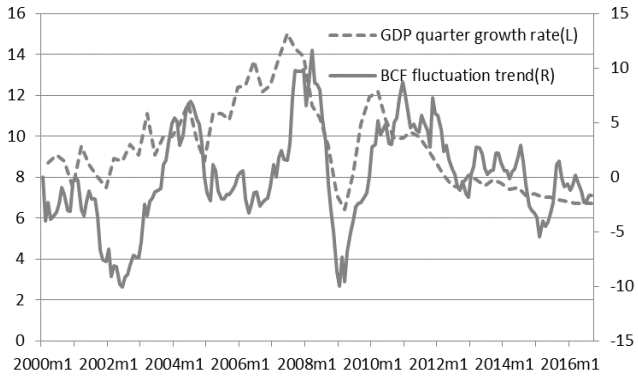
From Figure 1a, it can be seen that the common factors formed by the DF model from two different sets of economic index systems are quite similar in shape, but the peaks and troughs of the curve are different in time. Both BCF (1) and BCF (2) have cyclic fluctuation and can describe the fluctuation law of business cycle from different dimensions. Indexes in Model 1 are objectives of the macro-regulation policy, and according to the results of counter-cyclical regulation corresponding to the economic operation, they lag behind those in Model 2 in general, but they can reflect the stabilizing effect on the current economic operation; indexes in Model 2 are synchronization indicators of the economic system operation, and they show greater volatility, which do not meet the actual performance. By combining the advantages of the two sets of economic indexes, we use the average weighting method to synthesize a common factor BCF which can reflect the business cycle.

Table 2. Estimation results of DF model based on final data.

	Variables	*Common Factors*	*EGR*	*CACGR*	*IAVGR*	*CPI*
Model One	First-order Lag	1.759*** (0.000)				
	Second-order Lag	0.788*** (0.000)				
	Load Factors		0.011 (0.204)	0.441*** (0.000)	0.139*** (0.003)	0.230*** (0.000)
	VAR (.)		1.086*** (0.000)	19.326*** (0.000)	20.707*** (0.000)	0.135*** (0.000)
	Variables	*Common Factors*	*IFAGR*	*TRSCGGR*	*TEGR*	*M2GR*
Model Two	First-order Lag	1.632*** (0.000)				
	Second-order Lag	0.705*** (0.000)				
	Load Factors		0.122* (0.060)	-0.055** (0.030)	-0.404*** (0.001)	0.244*** (0.000)
	VAR (.)		18.211*** (0.000)	2.661*** (0.000)	49.064*** (0.000)	0.122*** (0.000)

Note: "***", "**" and "*" respectively indicate significant results at 1%, 5% and 10% significance level





(a). Comparison between BCF (1) and BCF (2) (b). Comparison between BCF and GDP

Figure 1. Business cycle factor (BCF) composition and comparison with quarterly GDP.

It can be seen from Figure 1b that BCF and GDP growth rate are basically the same in the form of variations, and meanwhile, BCF, with obvious periodicity, can reflect higher frequency fluctuations, which facilitate further characteristics analysis. This means that BCF can describe more accurately China's business cycle fluctuations.

The differences between the common factors measured by the models are caused by diverse index system selection. The relationship between the final BCF and the indexes can be reflected by the correlation coefficient. Table 3 shows the correlation between BCF and indexes in each group.

Table 3. The correlation between BCF and indexes.

Factors(1) composition	*Correlation with BCF*	*Factors(2) composition*	*Correlation with BCF*
IAVGR	0.2421	IFAGR	0.7279
CPI	**0.9583**	TRSCGGR	0.6350
EGR	0.5272	TEGR	0.2190
CACGR	0.6783	**M2GR**	**0.8964**

From Table 3 and Table 2, it can be seen that indexes with relatively high correlation have correspondingly larger parameter load factor value in the model. In Model 1, the largest correlation coefficient with BCF is CPI, which reflects that the main purpose of economic development is to satisfy residents' consumption, and it conforms to the objective of macroeconomic policy. In Model 2, the largest correlation coefficient with BCF is M2, reflecting the need for financial support to economic operation and the inseparable relationship between business cycle fluctuations and the financial cycle. Therefore, the final business cycle factor obtained by combining two groups of common factors, can not only reflect the power and purpose of economic operation more accurately, but also reflect that the business cycle is the result of the economic system itself; besides, the final factor can also reflect the impact from the macro-regulation policies, making the business cycle exhibits complex nonlinear features, and thus getting better measurement results.

3.3. Recognition the Turning Points of the Business Cycle

According to Harding and Pagan's "Trough-Trough" method, the common factors of economic operation from January 2000 to September 2016 are divided into five stages, see Figure 2 Stage I～V. The long-term trend parts are extracted by HP filtering method. After 2000, the mean and volatility of China's business cycle fluctuated steadily. This not only relates to the international economic environment, but also is inseparable from China's further deepening of reform and gradual improvement of macroeconomic regulation and control.

From the whole economic operation, it can be seen that the long-term trend has the feature of cyclical fluctuation and its mean is steady. The trend component of the business cycle fluctuation factor basically coincides with the cycle performance divided by the business cycle turning point recognition. It indicates that the cyclicality of economic operation is the result of active adjustment of economic operation system, which is self-generated and is the general law of economic operation. The gradually steady mean value is not the result of the gradual disappearance of the business cycle, but the outcome of gradual smooth by the national economic policy to stabilize the economic fluctuations. From this we can see that since 2013, China's economic operation is in a phase of long-

term downward adjustment and short-term cyclical contraction. For single cycle stage, different business cycle stages differ and maintain a progressive relationship. The first and the third stage display the pattern of "slow-rise and steep-fall", while the second and the fourth stage exhibit a pattern of "steep-rise and slow-fall". The fluctuation level of the fifth stage is stable. The mean of the five stages are not the same. The first and the fifth stage exhibit negative fluctuations. The "slow-fall" at the end of the second stage achieved a "soft landing" of the business cycle, providing a basis for economic release for the next cycle. Even if the financial crisis that began in 2008 led to a sharp decline in the third stage, the fourth stage still came quickly. It can be seen that different stages of the business cycle have close progressive relationship, and each stage has the depth and steepness asymmetric characteristics.

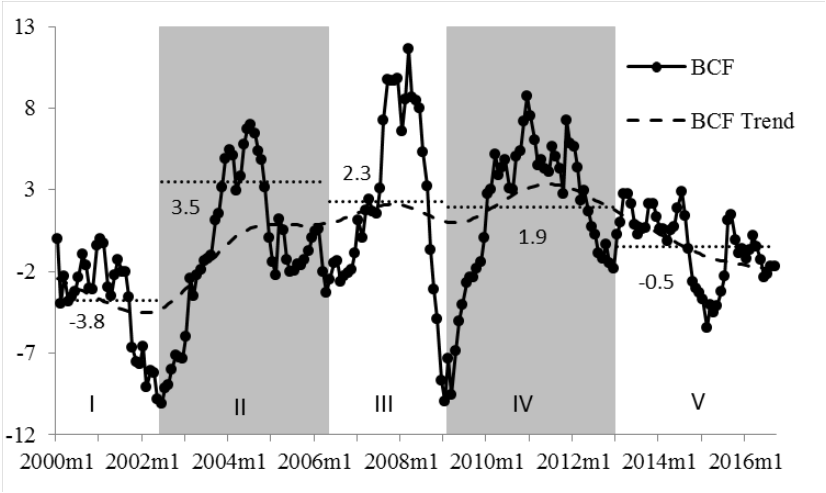


Figure 2. The trend and stage division of business cycle fluctuations.

4. The Asymmetric Characteristic Test of China's Business Cycle

In Figure 2, the five cycle stages are distinguished by shading. In order to further analyze the fluctuation characteristics and the main manifestations of these stages, the nonparametric method was used to test the asymmetry of each business cycle.

4.1. The Asymmetry Test of Business Cycle's Stages

The "three-tuple" method is used to test the asymmetry of five stages of economic operation common factors since 2000. The results are shown in Table 4. It can be seen from the results of the five-stage descriptive statistics, that since 2000, the mean of China's business cycle factor tends to be zero, and the variance also exhibits a decreasing trend, showing a stable and smooth trend of business cycle fluctuations. In the course of economic operation, there appears a "big easing" phase similar to that of the US economy. In particular, since 2013, the economic fluctuation mean and tendency converged, and the economic system shows normalized characteristics of smooth operation.

The "three-tuple" test to the depth asymmetry of the business cycle factor original sequence shows that the same-shape depth asymmetry is detected in the first, fourth and fifth stages. According to the positive and negative statistics, the three stages can all be considered as "low-peak

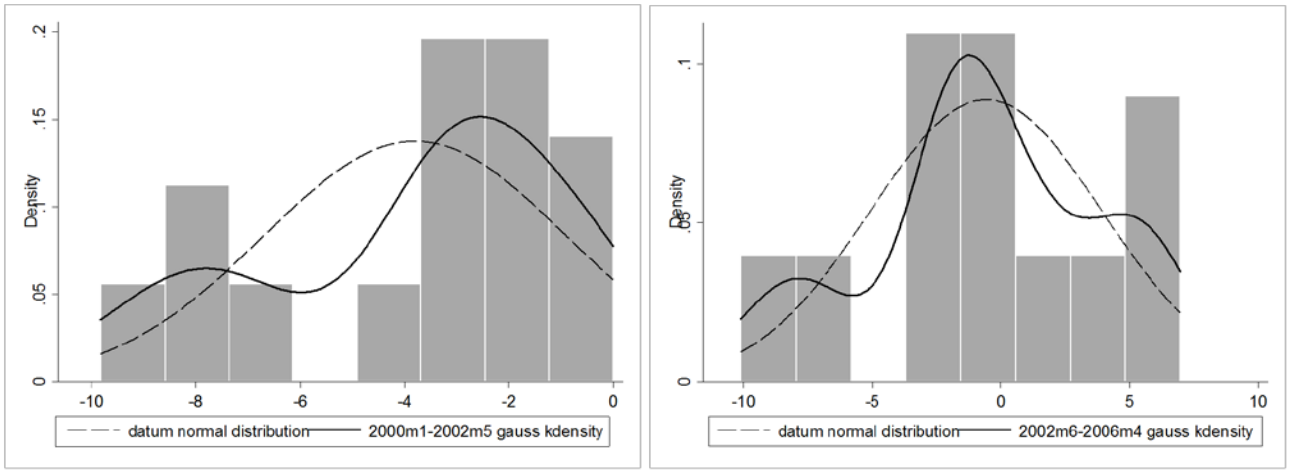
and deep-trough" asymmetry type, indicating that the economic operation contraction in the decline stage is relatively tight, and the economic structure since the economic transition in China is fragile. Once the economy turns downward, the trough extent is more significant. Currently, the urgent need is to adjust the economic structure and form a stable economic operating system. At the same time, the steepness asymmetry test by the "three-tuple" method to the business cycle factor differential sequence shows that, the steepness asymmetry is detected in the first and the fifth cycle but their shapes are different. In the first stage, the asymmetry is observed to be the "slow rise and steep fall" type, while that in the fourth stage is the "steep-rise and slow-fall" type. These features indicate that the repair function of the economic system enhanced, and even impacted by the financial crisis of 2008, it can recover quickly.

Table 4. Asymmetry tests of various stages of the business cycle.

Stages of Business Cycle	*Descriptive Statistics*		*The "three-tuple" Test*		*Asymmetry*
	Mean	*Variance*	*"Depth" Asymmetry Z value (P value)*	*"Steepness" Asymmetry Z value (P value)*	
I: 2000m1–2002m5	-3.797	2.899	-3.431(0.000)***	-1.906(0.028)**	low peaks and deep troughs slow rise and steep fall
II: 2002m6–2006m4	3.572	4.490	-0.456(0.324)	-0.676(0.249)	not significant
III: 2006m5–2009m1	2.294	5.652	0.759(0.224)	-0.508(0.306)	not significant
IV:2009m2–2012m12	1.856	4.210	-4.628(0.000)***	2.629(0.004)***	low peaks and deep troughs steep rise and slow fall
V :2013m1–2016m9	-0.484	2.145	-2.963(0.002)***	0.686(0.246)	low peaks and deep troughs

Note: "***", "**" and "*" respectively indicate significant results at 1%, 5% and 10% significance level

In order to illustrate more clearly the asymmetry of business cycle in different stages, the data distribution is simulated by Gaussian kernel density estimation, which is compared with the normal distribution. See Figure 3. A comparison of the results from each stage is given, where all the samples are simulated. The distributions of the kernel density of different stages and the reference normal distribution of corresponding sample intervals are shown in Figure 3, and the results of the "three-tuple" method are verified. It is pointed out that, the whole distribution simulation of the whole sample shows that the fluctuation distribution of the business cycle is close to the normal distribution, which means that China's economic fluctuation has the trend of regression as a whole and the economic operation has a convergence tendency.



(a) **(b)**

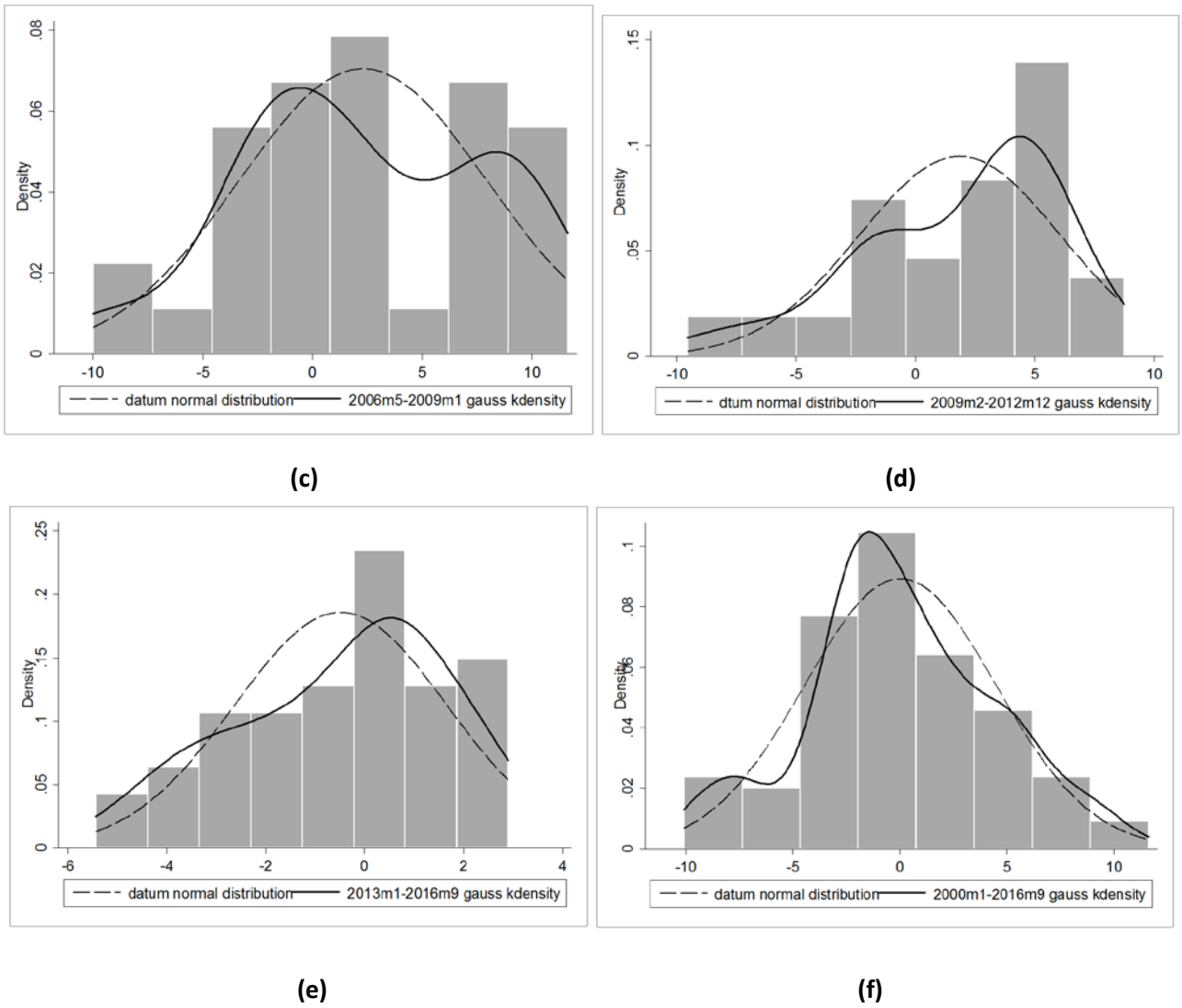


Figure 3. The nuclear density distribution and the basis normal distribution map of the sample in the first to the fifth cycle stages.

4.2. Analysis of the Causes of Asymmetric Business Cycle in Different Stages

The causes of the asymmetry of China's business cycle are not only the internal immaturity of the market economy system, but also the factors of the planned economy influence in the process of economic transformation, as well as the intervention of the national macro-regulation policy and the impact from foreign economic fluctuations. Because the formation reasons of asymmetric business cycles are different, the asymmetric forms and extent are of great differences.

At the first stage of the business cycle, that is, from January 2000 to May 2002, the obvious asymmetry of "low-peak and deep-trough" type is detected, and the steepness asymmetry of "slow-rise and steep-fall" is also significant. The main reason for the formation of this type of symmetry is due to China's accession to WTO in 2001, when foreign economic impact on China's economy increased, and shocks from foreign economic fluctuations declined deeply in a short period of time. The asymmetry in the second and the third stage of the business cycle is not significant. From June

2002 to April 2006, the business cycle stage maintains sustained, stable and rapid development due to the "soft expansion" economy which applied the "double stable" policy to achieve "high smooth" and "good and fast" development. Benefit from the robust economy policy, this stage does not show significant asymmetry. From May 2006 to January 2009, the beginning of the business cycle stage corresponds to the rapid economic development, while the contraction in the latter part of this period corresponds to the outbreak of the global financial crisis in the third quarter of 2008. Fast development turned to rapid response to the global financial crisis, and the economy suffered a deep downturn, and during this period, a positive fiscal policy and moderately loose monetary policy were applied. Under the external financial crisis shock and strong economic policies, although the magnitude of the periodic fluctuation is large, its asymmetry is not significant.

We are particularly concerned with the cyclical shape of the last two stages. The starting point of the fourth stage is to cope with the2008 financial crisis and its ending point corresponds to the emergence of the economic New Normal. This stage is tested to bear the "low-peak and deep-trough" depth asymmetry and the "steep-rise and slow-fall" steepness asymmetry. The rapid recovery of the economy is the result of the economic stimulus of RMB 4 trillion which pull economy out of the trough and then slow down the process. A variety of reasons for economic growth slow-down dragged China's economic growth into the New Normal stage.

Stage V is the continuation period of the formation of China's economy new normality, and it is also the stage of forming and stabilizing the New-Normal main trend characteristics. Because of the low data volatility during this period, the test results of the statistics only show a significant "low-peak and deep-trough" depth asymmetry. The fundamental reason for the business cycle fluctuation characteristics in this stage is that the inherent dynamic mechanism of the business cycle has changed, and the new normality of China's economy has become a new form of economic fluctuation. In addition, during this period the business cycle has strong continuity and trend characteristics, which is the demand of China's economic structure optimization and industrial structure upgrading to make the corresponding macro-regulation policies to ensure the new trend of economic normality.

5. Conclusion

In this paper, we use the dynamic factor model to measure China's business cycle fluctuation since January 2000 by selecting two sets of macroeconomic indexes. Based on the stage division of the business cycle, we use the "three-tuple" method to analyze the asymmetry of different business cycle stages, and the reasons of forming the asymmetry are also explored. The conclusions are as follows:

First, the multivariate dynamic factor model can effectively measure China's business cycle. The model's analysis results of different groups of indexes are consistent in form, but the difference in the measurement results of different groups of indexes reflects the subjectivity of index selection and the diversity of the indicators' characteristics. Considering the selection of different groups of indicators can describe more effectively the performance characteristics of China's business cycle.

Second, different stages of China's business cycle display asymmetric characteristics. China's business cycle has asymmetric characteristics, but the regulation means of the macroeconomic policy facing the economic operation situation tend to diversify. Increasing regulation capacity, coupled with the impact of various external uncertainty, result in different forms of asymmetric business cycles under the combined effect of various forces.

The last but not the least, China's business cycle is characterized by long-term convergence. Since the New Normal, the significant asymmetry features of economy disappear, replaced by the form of weakened activity and decelerate stabilization. The trailing shape of the business cycle means that, at a great probability, China's economy is hovering in a period. It is the convergence trend of the New Normal economy. Such moderate economic growth will provide a good opportunity to optimize the structure, adjust the industry, buffer the domestic and foreign economy shock and ease the pressure of macro-regulation.

Conflict of Interest

All authors declare no conflict of interest.

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